DOE-XXXX

DRAFT

Environmental Implementation Guide for Radiological Survey Procedures

Office of Environmental Policy and Assistance
Assistant Secretary for Environment, Safety, and Health
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8. DATA REPORTING AND MANAGEMENT

8.1 FIELD DATA

Records must be legible, thorough, and unambiguous. Data are recorded in indelible ink, signed, and dated. Enough data must be collected to enable an independent evaluation of the site status. Changes are made by striking through the item to be changed with a single line, entering the corrected information, and initialing and dating the change. Where practical, survey data should be recorded on standardized forms. Other information, for which forms are not appropriate, is recorded in a bound logbook. All data and supporting information, necessary to substantiate the survey findings, should be considered permanent legal records and, as such, should be protected from damage or loss and retained for a time period appropriate for such records.

8.2 DATA REPORTING

Documentation for survey reports should provide a complete and unambiguous record of the radiological status of the site / facility relative to the requirements of the particular survey type conducted. See Sect. 3.1 for a discussion of the different types of surveys and the extent of data required to satisfy the aim of the investigation. In addition, sufficient information and data should be provided to enable an independent re-creation and evaluation at some future date of both the survey activities and the derived results.

The content and form of the report will be dictated largely by the type of survey and the resulting data requirements. The report should provide a synopsis of the historical information detailing specifics concerning former processing activities as listed in Sect. 2. This would include locations of activities, radionuclides involved, release points, and information regarding past and / or present buildings and other structures. The location and type of facility, and a description of the physical characteristics of the site should be given. Among relevant details are ownership history, current activities on the site, and topographical data and geographical / geological data that may have been, or may now be, a factor in the extent or distribution of contamination. Data sources will include information from any previous surveys, the survey field data sheets and maps, lab analysis results, photographs, QA documentation, chain-of-custody forms, and the documents identified during the review as described in Sect. 2.

Much of the information for a particular report will likely be available from other sources and may only require a summation or reference in the report. Such sources may include documentation detailing previously conducted surveys, decommissioning and survey design and work plans, and the various information required as part of the accountability program (i.e., lab reports, survey data, QA documentation, chain-of-custody forms, etc.)

The general approach used for the survey procedures and the reasons for adopting that approach should be described along with the types of measurements and samples taken and the methods for procuring them. Background levels and concentrations should be selected for

comparison with survey results, and the rationale for the selection of that data should be provided. See Sect. 4.4 for a complete discussion of background baseline material.

Tables and figures relating survey findings should be supported by detailed discussion in the text of the report. All relevant data should be provided in a clear and concise manner. Figures may include layouts of surveyed areas upon which measurement and sample results may be superimposed. The survey results should be compared to the applicable guidelines and any problem areas specifically addressed. The statistical design, analysis, and test methods should be identified and results of tests included and interpreted.

A generic report format used for any of the types of radiological surveys discussed in Sect. 1 is provided below.

RADIOLOGICAL SURVEY REPORT FORMAT

I. Abstract

This section should be a brief, executive-type summary of survey results. It should include a brief statement about exposure evaluation results.

II. Introduction

This section should include:

a. purpose of the survey;
b. when the survey was conducted and by whom;
c. a brief history of the site, or if it is a vicinity property, a history of the associated candidate site (include process history if appropriate—use only published or documented information); and
d. a description of property [include area maps, site-scaled drawings and photographs (using care not to divulge site location or ownership if appropriate—use codes for all references to site location as needed)].
e. references to related studies.

III. Survey Methods

This section should include a simple listing of the types of measurements and samples taken. The appendices or documents that describe the survey plan for the site and those that detail the survey instrumentation and sample analysis methods employed should be referenced. A brief description of the survey techniques and instrumentation should be included.

Include a synopsis of any special activities conducted to allow access for surveying, and identify and justify, if necessary, areas not surveyed. Discuss special problems or conditions affecting the conduct of the survey.

The organization and arrangement of the reported data is, at least partly, dictated by the unique characteristics of the site/facility and may require explanation. Any special nomenclature arbitrarily assigned to areas, structures, or materials for the purpose of identification of locations and measurements should be defined.

IV. Survey Results

Subsections should discuss results for each measurement type. Text should summarize data in terms of range and average levels observed. Appropriate figures and detailed data tables should be referenced. For on-site measurement results, comparisons to guidelines and/or normal background levels should be mentioned in this section. In addition, specific requirements for each section are provided as follows.

a. Background Radiation Levels

Reference or present a brief description of areas and results included in background determinations. If applicable, state values and locations of background levels found on site.

b. Indoor Survey Results

This section should describe the results of all measurements, and include a detailed discussion of any residual contamination discovered. Results of the radiological survey should be compared to background and guideline values. The following parameters, where applicable, should be detailed, and appropriate documentation in the form of tables and/or figures prepared to substantiate the findings:

1. measurements of external radiation levels,
2. sampling results [dust, paint chips, structural material, tap water (if supply is a private well]), drain residues, etc., including results of indirectly measured concentrations of radioactive materials (i.e., smear analyses),
3. radon and radon daughter measurements, thoron and thoron daughter measurements,
4. air monitoring results,
5. subsurface investigations;
   - reference to appended hole-logging graphs.

c. Outdoor Survey Results

All outdoor data should be discussed in this section and any residual contamination described. Results should be compared to background and guideline values. The following parameters should be detailed and appropriate documentation in the form of tables and/or figures prepared to substantiate the findings:

1. measurements of external radiation levels,
2. surface soil sampling results,
3. subsurface soil investigations,
   - reference to appended hole-logging graphs,
4. measurements of potentially transferable contamination where suspected (e.g., residues on concrete pads, roof surfaces around vents or other surfaces where airborne effluents could deposit and accumulate),
5. other samples;
   - water as appropriate; e.g., surface water, core-hole water, vegetation, drain residues, collected debris around or in effluent systems such as roof vents, sumps, sewers, etc.

V. Significance of Findings

The introductory paragraph of this section should state that, based on the results of the survey, the following information can be derived.

a. Extent of Contamination - Discuss the areal extent of contamination (or conversely, it's absence) indoors and outdoors. The location(s) of measurements and/or samples exceeding applicable guidelines should be outlined. A discussion of the area(s) involved and an estimate of the extent of contamination in each area should be detailed.

b. Evaluation of Radiation Exposures - Summarize the bases for evaluation, assumptions used, and preliminary calculated estimate of the increased risk, if any, to individuals on site.

VI. References

VII. Appendices

Appendices should detail any additional information (such as auger-hole logging graphs) not appropriately addressed elsewhere in the document.

9. QUALITY ASSURANCE

The top tier quality assurance (QA) directives for DOE elements and DOE management and operating (M&O) contractors are 10 CFR Part 830.120 and Order DOE 5700.6C. Guidance documents for both directives are

- *Implementation Guide for Use With 10 CFR Part 830.120, Quality Assurance,* G–830.120-Rev. 0, U.S. Department of Energy, April 15, 1994; and

- DOE 5700.6C, Attachment I, *Quality Assurance Program Implementation Guide, U.S. Department of Energy,* August 21, 1991.

The quality assurance/quality control (QA/QC) program will establish the data quality objectives for the survey and thereby determine, to a significant extent, the survey design. This program must then operate at all stages of the survey through final validation of the data and interpretation of the results.

It is important that the reader understand the fundamental differences between QA and QC. QA refers to the program established to ensure that critical activities are identified and properly monitored and documented; QC refers to those elements of the QA program that provide for control and measurement of various processes to demonstrate acceptable system performance.

The responsibility for quality assurance rests with the organization performing the survey, including work on-site that is contracted or samples analyzed at off-site laboratories. Quality control on all measurements is necessary, and measurement standards must be traceable and reproducible to the National Institute for Science and Technology (NIST).

To make the decision to release a site for appropriate future use, a documented and approved quality assurance program is necessary for all steps of the design and implementation of the radiological survey. The quality assurance program must address all ten criteria defined in 10 CFR 830.120 and Order DOE 5700.6C.

9.1 QUALITY ASSURANCE PROGRAM

A documented quality assurance program shall be planned, implemented, and maintained in accordance with Order DOE 5700.6C, “Quality Assurance.” ANSI/ASME NQA-1, “Quality Assurance Program Requirements for Nuclear Facilities” (1989) may be helpful. Review and approval of the QA program will be made by DOE or its contractor. The establishment of the program shall include consideration of the technical aspects of the activities affecting quality. The program shall provide control over activities affecting quality to an extent consistent with their importance. The program shall be established at the earliest time consistent with the schedule for accomplishing

the activities. Useful references include ANSI/ASCQ, 1994; ASME/ASME 1989a, 1989b, 1989c; ASTM C1009; EPA 1980a; EPA 1980b; EPA 1994a; EPA 1994b; EPA 1993b; ISO 9000; and MIL-Q-9858A.

The data usability assessment is defined by six evaluation criteria as follows:

- Reports to person responsible for site assessment,
- Documentation,
- Data sources,
- Analytical method and detection limit,
- Data review and,
- Data quality indicators.

The program shall provide for the planning and accomplishment of activities affecting quality under suitably controlled conditions. Controlled conditions include the use of appropriate equipment, suitable environmental conditions for accomplishing the activity, and assurance that prerequisites for the given activity have been satisfied. The program shall provide for any special controls, processes, test equipment, tools, and skills to attain the required quality and for verification of quality.

The program shall provide for indoctrination and training, as necessary, of persons who perform activities that affect quality to ensure that suitable proficiency is achieved and maintained.

Management of those organizations that implement the QA program, or portions thereof, shall regularly assess the adequacy of that part of the program for which they are responsible and shall ensure its effective implementation.

9.2 ORGANIZATION

The organizational structure, functional responsibilities, levels of authority, and lines of communication for activities affecting quality shall be documented. Persons or organizations responsible for ensuring that an appropriate QA program has been established and for verifying that activities affecting quality have been correctly performed shall have sufficient authority, access to work areas, and organizational freedom to:

- identify problems relating to quality;
- initiate, recommend, or provide solutions to problems relating to quality through designated channels;
- verify implementation of solutions; and
- ensure that further processing, delivery, installation, or use is controlled until proper disposition of a nonconformance, deficiency, or unsatisfactory condition has occurred.

Such persons or organizations shall have direct access to responsible management at a level where appropriate action can be effected. Such persons or organizations shall report to a management level such that required authority and organizational freedom are provided, including sufficient independence from cost and schedule considerations.

9.3 PERSONNEL REQUIREMENTS

9.3.1 Qualifications

Education, experience, and any other requirements of qualification should be specified for each position in the organization.

9.3.2 Training

All personnel conducting surveys and performing other activities described in this manual must receive training to qualify in the procedures performed. The extent of training and qualification must be commensurate with the education, experience, and proficiency of the individual, and the scope, complexity, and nature of the activity. Training must be designed to achieve initial proficiency, and to maintain that proficiency at least over the course of the survey process or other activity. Records of training, including testing to demonstrate qualification, must be documented.

9.4 QUALITY IMPROVEMENT

Quality improvement is based on the premise that all work activities can be planned, performed, measured, and improved. Management is responsible for building a culture in which improvement is continuous and an integral part of the organization.

Management policy for continuous improvement should encourage the development and exploration of new ideas for improvement. Management policy for continuous improvement should be documented and communicated to all levels of the organization.

The continuous improvement approach focuses on problem prevention, corrective action, and performance improvement rather than relying on post-process inspection to prevent defective items from reaching customers. Process performance should be continuously measured and evaluated to identify improvement opportunities. Each manager is responsible for managing process quality within their organization.

9.5 CONTROL OF RECORDS AND DATA

Records that furnish documentary evidence of quality shall be specified, prepared, and maintained. Records shall be legible, identifiable, and retrievable. Records shall be

protected against damage, deterioration, or loss. Requirements and responsibilities for record content, transmittal, distribution, retention, maintenance, and disposition shall be established and documented. Retention of sample-related data is addressed in DOE 1324.2A.

9.6 WORK PROCESSES

9.6.1 Instructions and Procedures

Activities affecting quality shall be prescribed by and performed in accordance with documented and approved instructions or procedures of a type appropriate to the circumstances. These documents shall include or reference appropriate quantitative or qualitative acceptance criteria for determining that prescribed activities have been satisfactorily accomplished.

9.6.2 Data Quality Objectives

All projects involving the generation, acquisition, and use of environmental data shall be planned and documented. The type and quality of environmental data needed for their intended use shall be defined and documented using the EPA Data Quality Objectives (DQO) process identified in EPA Order 5360.1 (1984), or its equivalent. Determination of the type and quality of environmental data needed shall involve key users of the data as well as those responsible for activities affecting data quality. Planning activities shall be documented to assure that participants in the environmental data operations are informed of and understand the requirements of the project in a timely manner. Results of planning activities shall be subject to review and approval according to QA program requirements and line management decisions.

9.6.3 Field Quality

9.6.3.1 Sample control

One of the most important aspects of sample documentation is to ensure that accountability of the sample is maintained. It is imperative that an accurate record of sample collection, transport, analysis, and disposal be maintained and documented. Such records ensure that samples are not lost nor tampered with, and that the sample analyzed in the laboratory is actually and verifiably the sample taken from a specific location in the field.

9.6.3.2 Packaging and labeling

Approved documented procedures shall be established for packaging and labeling of samples. Each sample shall have its own unique sample identification number and shall be packaged to prevent any loss in the integrity or the volume of the sample.

9.6.3.3 Shipping and transportation

Approved documented procedures shall be established for the shipping and transportation of samples, equipment, and supplies. Appropriate laws shall be considered when selecting shipping containers and making transportation arrangements. The responsible individual(s) must consult with the programmatic transportation departments or offices responsible for the shipping and transportation process. Programmatic, organizational, local, State, DOE, and other Federal organizations' regulations and guidelines must be taken into account when applicable. Procedures must comply with Federal transportation regulations (49 CFR; Order DOE 1540).

9.6.3.4 Chain of custody

Sample custody should be assigned to one individual at a time. This will prevent confusion of responsibility. An acceptable chain-of-custody is maintained when the sample is (1) under direct surveillance by the assigned individual, (2) maintained in a container with tamper-free seals or (3) within a controlled-access facility.

The chain-of-custody record on a standard form is initiated by the individual collecting or overseeing the collection of samples. A copy of this form must accompany the samples throughout transportation, analyses, and storage ending only with disposal. Any break in custody or evidence of tampering must be documented.

9.6.3.5 Archiving and storage

Storage of Samples. Samples shall be tracked under the conditions of Sect. 9.6.3.4, Chain of Custody.

Archiving of Samples. Samples must be archived according to guidelines detailed in programmatic requirements. General guidance for archival sample selection is as follows:

- samples collected by the independent verification contractor (IVC) as part of the verification surveys,
- samples obtained from the project management contractor (PMC) to confirm the accuracy of analytical procedures,
- approximately 10% of the post-remedial-action samples, selected at random from the post-remedial-action data tables,
- samples from nonremediated areas, chosen from archives of the designation survey contractor (DSC) / PMC,
- special samples representing areas of special concern to property owners, DOE, State agencies, etc.; areas of conflict between the IVC and PMC; areas where exceptions to the guidelines were implemented.

Sample selection will begin during the verification activities and continue for approximately six months following completion of the certification statement. The IVC will retain all archived samples for a minimum of five years beyond the notice of certification in the Federal Register. At that time, the IVC will request approval from DOE/HQ for disposal of the archived samples.

9.7 CONTROL OF MEASURING AND TEST EQUIPMENT

Tools, gauges, instruments, and other measuring and test equipment used for activities affecting quality shall be controlled and, at specified periods, calibrated and adjusted to maintain accuracy within necessary limits.

Proper maintenance, calibration, and testing of measuring equipment is necessary to ensure the validity of the survey data. Procedures, responsibilities, and schedules for calibration and testing must be documented. Calibrations of field and laboratory equipment should be based on standards traceable to NIST. In those cases where NIST-traceable standards are not available, standards of an industry-recognized organization (e.g., the New Brunswick Laboratory for various uranium standards) may be used.

Equipment must be tested and calibrated before initial use and must be recalibrated when maintenance or modifications that could invalidate earlier calibrations are performed. Minimum calibration frequencies must be established.

QC tests of measuring equipment must be conducted (at a minimum) once each day that the equipment is used, and the results should be recorded in tabular or graphic form and compared with predetermined ranges of acceptable performance. Equipment that does not conform to the performance criteria must be immediately removed from service until the deficiencies can be resolved. (An exception to requirements for equipment calibration and routine QC tests may be made for certain laboratory procedures that make use of an internal standard or spike because in such procedures each analysis is, in itself, a calibration.)

All maintenance, calibration, and testing records should become part of the record developed for each item of measuring equipment.

9.8 DATA VALIDATION

Data from environmental data operations used to characterize environmental processes and conditions shall be qualified according to intended use of the data. Data shall be qualified according to approved procedures specified during design that provide for documentation of the decision process and factors used in arriving at the choice of the qualification method. This process shall include the correct application of statistical methods during the assessment process. The decision to qualify the data for their intended use shall be based on reconciliation with the performance measures for

the project obtained originally by the EPA DQO process or its equivalent. Any limitations on data use shall be identified quantitatively and fully documented.

Project reports containing data or reporting the results of environmental data operations shall be reviewed independently to confirm that the data or results are presented correctly. Such reports shall be approved by line management for release, publication, or distribution.

9.9 DESIGN

Definition, control, and verification of design is necessary to ensure that systems, structures, and components fulfill contractual requirements and customer expectations. Design work should be based on sound engineering and scientific principles. A formal design process should be established that provides control of design inputs, outputs, verification, configuration and design changes, documentation, records, and technical and administrative interfaces.

Designs should provide for appropriate inspection, testing, and maintenance to ensure continuing reliability and safety of the system, structure, or component. The design should consider the expected use and life expectancy of the system, structure, or component in order to address appropriate disassembly and disposal requirements.

9.10 PROCUREMENT CONTROL

The procurement of items and services shall be controlled to ensure conformance with specified requirements. Such control shall provide for the following as appropriate: source evaluation and selection, evaluation of objective evidence of quality furnished by the supplier, source inspection, audit, and examination of items or services upon delivery or completion.

Tests required to verify conformance of an item or activity to specified requirements shall be planned and executed. Characteristics to be inspected and inspection methods to be employed shall be specified. Inspection results shall be documented. Inspection for acceptance shall be performed by persons other than those who performed or directly supervised the work being inspected.

9.10.1 Procurement Documents

Procurement documents of items or services shall be reviewed to ensure that quality is included or invoked. These documents include purchase requisitions, orders, and specifications. The procurement document pathway with responsibilities for stages of the process shall be documented. In addition, measures shall be established to ensure that purchased items or services conform to procurement documents. Where applicable, the following items should be addressed in the procurement documents.

- Define the scope of services to be provided.
- Define and specify all technical requirements.
- Define the requirements of the supplier's QA program.
- Define access requirements to the supplier's facilities and records for inspection or audit by the purchaser.
- Define supplier-generated documentation requirements.
- Define how changes, nonconformances, and deviation requests will be handled.
- Define spare and replacement parts requirements.

9.10.2 Direct Purchasing

The direct purchase of items shall be controlled. Approved documented procedures shall be established for direct purchasing using guidelines found in Sect. 9.11.

9.10.3 Subcontracts

Subcontracts of materials and services shall be controlled. Approved documented procedures shall be established for subcontracts using guidelines found in Sect. 9.11.

9.10.4 Control of Nonconforming Items

Items that do not conform to specified requirements shall be controlled to prevent inadvertent installation or use. Controls shall provide for identification, documentation, evaluation, segregation when practical, and disposition of nonconforming items and notification of affected organizations.

9.11 INSPECTION AND ACCEPTANCE TESTING

Inspections/tests are accomplished to verify that physical characteristics and functions of systems, structures, and components are acceptable to the organization that will use the systems, structures, and components. Systems, structures, and components requiring inspections or tests should be identified early in the design phase.

Inspections and tests should be conducted according to a graded approach. The inspection/test process should identify the status of systems, structures, and components requiring examination to ensure that failed or untested systems, structures, and components are not used. Inspections/tests should be performed by technically qualified personnel who have the freedom of access and communication to report inspection/test results.

All personnel should check items supplied to their work process to ascertain that the items are correct and suitable for use. All personnel should check their process output to verify that it meets or exceeds requirements.

9.12 MANAGEMENT ASSESSMENT

Managers at every level should periodically assess the performance of their organization to determine how well leadership is being provided to enable the organization to continuously meet the customer's requirements and expectations. This assessment should place emphasis on the use of human and material resources to achieve the organization's goals and objectives. Strengths and weaknesses affecting the achievement of organizational objectives should be identified so that meaningful action can be taken to improve quality. Direct observation of work is an effective method of management assessment. Other methods include interviews of workers, reviews of documentation, and conduct of drills or exercises.

Management assessments should focus on how well the integrated quality assurance program is working and should identify management problems that hinder the organization from achieving its objectives in accordance with quality, safety, and environmental requirements.

Processes being assessed should include strategic planning, organizational interfaces, cost control, use of performance indicators, staff training and qualifications, and supervisory oversight and support. Effective management assessments should evaluate such conditions as the state of employee knowledge, motivation, and morale; the amount of mutual trust and communication among workers; the existence of an atmosphere of creativity and improvement; and the adequacy of human and material resources.

Management assessments should be documented. Senior management should take prompt action, and document resulting decisions in response to recommendations resulting from the management assessment process. Follow-up should include an evaluation of the effectiveness of management's actions.

9.13 AUDITS

Planned and scheduled audits shall be performed to verify compliance with all aspects of the QA program and to determine its effectiveness. These audits shall be performed according to written procedures or checklists by personnel who do not have direct responsibility for performing the activities being audited. Audit results shall be documented and shall be reported to and reviewed by responsible management. Follow-up action shall be taken where indicated.

9.13.1 Surveillances

Surveillance applies to all projects and activities that require a high degree of confidence that the final product or service will meet specified requirements. Surveillance activities necessary to verify the conformance of an item or activity to specified requirements shall be planned, executed, and documented. Surveillance activities shall

be performed such that verification is commensurate with the level of quality specified for the observed item or activity.

9.13.2 Internal Audits

Contractor program managers and their QA representative(s) are responsible for conducting internal audits of their programs to verify compliance with the objectives outlined in Sect. 9.9.

9.13.3 External Audits

DOE program managers and their QA representative(s) are responsible for conducting audits of their programs to verify compliance with the objectives outlined in Sect. 9.9.

9.13.4 Corrective Actions

Conditions adverse to quality shall be identified promptly and corrected as soon as practical. In the case of a significant condition adverse to quality, the cause of the condition shall be determined and corrective action taken to preclude recurrence. The identification, cause, and corrective action for significant conditions adverse to quality shall be documented and reported to appropriate levels of management; follow-up action shall be taken to verify implementation of this corrective action.

9.14 INDEPENDENT ASSESSMENT

Management should establish and implement a method for independent assessment of organizations, programs, and projects in order to evaluate the performance of work processes with regard to requirements and expectations of customers and toward achieving the mission and goals of the organization. The independent assessment process should use a performance-based approach with emphasis on results and with compliance viewed as the baseline. Assessments should be conducted on activities that most directly relate to final objectives and should emphasize safety, reliability, and product performance. Independent assessments may include such methods as inspections, peer and technical reviews, audits, surveillances, or combinations thereof.

Personnel performing independent assessments should have the necessary technical knowledge to accurately observe and evaluate activities being assessed. Personnel performing assessments should not have direct responsibilities in the areas they are assessing. Assessments should address management processes that affect work performance such as planning, program support, and training. Assessment personnel should not reinterpret or redefine the requirements specified in approved programs. The assessor's responsibilities include the following:

- evaluating work performance and process effectiveness;
- identifying abnormal performance and potential problems;

- finding opportunities for improvements;
- documenting and reporting results; and
- verifying satisfactory resolutions of reported problems.

Assessment results should be documented, presented to the organization that was assessed, and provided to the appropriate levels of management for review. Strengths and weaknesses affecting the quality of process outputs should be identified so that meaningful action can be taken to improve quality. The independent assessment process should include verification of the adequacy of corrective actions, including actions identified to prevent recurrence or to otherwise improve performance.

Assessment results should be tracked and resolved by management having responsibility in the area assessed. Follow-up review of deficient areas should be initiated as necessary.

Responses to assessments should include the following as applicable;

- action to correct the deficiency,
- cause identification,
- actions to prevent recurrence,
- lessons learned, and
- actions to be taken for improvement.

10. DEFINITIONS AND TERMINOLOGY

10.1 DEFINITIONS

ABSORBED DOSE. The energy imparted to matter by ionizing radiation per unit mass of irradiated material at the point of interest. The unit of absorbed dose is the rad. (The international system [SI] unit is the Gray.)

AERIAL SURVEY. A search for sources of radiation by means of sensitive instruments mounted in a helicopter or airplane. Generally, the instrumentation records the intensity, location, and spectral analysis of the radiation field.

ALPHA PARTICLE (RADIATION). A helium nucleus consisting of 2 protons and 2 neutrons and having a double positive charge.

ARCHIVED SAMPLES. Environmental samples (sediment and soil) stored for future retrieval or final disposal.

ARITHMETIC MEAN. Average value; sum of the individual data values divided by the number of observations.

ARITHMETIC STANDARD DEVIATION. An index used to quantify the variation within a set of data according to the formula .

$$s = \sqrt{\frac{3\,(x - \overline{x})^2}{n-1}}$$

where

s = standard deviation,
$\underline{x}$ = individual observation,
$\overline{x}$ = arithmetic mean,
n = number of observations.

AUDIT. A planned and documented activity performed to determine by investigation, examination, or evaluation of objective evidence the adequacy of and compliance with established procedures, instructions, drawings, and other applicable documents, and the effectiveness of implementation. An audit should not be confused with surveillance or inspection activities performed for the sole purpose of process control or product acceptance.

AUGERED HOLE. A hole produced by an auger drilled into the soil.

BACKGROUND RADIATION. Radiation arising from cosmic rays and natural radioactive sources indigenous to the region, area, or location under consideration.

BASE LINE. The first line laid on a grid system, to which all other grid lines are referenced; usually, the longest line in the grid, preferably along one property boundary.

BECQUEREL (Bq). The SI unit of quantity for radioactive material associated with 1 dps (2.7027×10^{-11} Ci).

BETA PARTICLE. An elementary particle emitted from a nucleus during radioactive decay that has a single electrical charge and a mass equal to that of an electron.

BIASED SAMPLE/MEASUREMENT. Samples/measurements taken from a location where radiation levels or other site characteristics are unusual.

CALIBRATION. The activity of measuring, determining, or verifying the accuracy of measurement by a particular instrument or device in relation to a predetermined standard or reference.

CANDIDATE SITE. Property formerly utilized under contract with MED/AEC/DOE and covered by a defined DOE program, or surplus DOE contractor facilities owned by the U.S. Government.

CERTIFICATION. The action of determining, verifying, and attesting in writing to the qualifications or validity of personnel, materials, or measurements.

CHARCOAL CANISTER. A canister that uses activated charcoal for absorbing radon gases.

CONTAMINATION. The presence of unwanted radioactive matter.

CONVERSION FACTOR. A mathematically derived factor experimentally determined that converts experimental system response to actual values.

CORE SAMPLE. Soil sample obtained by core drilling.

COUNT (RADIATION MEASUREMENTS). The external indication by a device designed to enumerate ionizing events occurring within a given detector.

DAUGHTER. A nuclide formed by the radioactive decay of another nuclide, which in this context is called the parent.

DECONTAMINATION. The removal of chemical, biological, or radiological contaminants from, or their neutralization on, a person, object, or area to within levels established by governing regulatory agencies.

DESIGNATED SITES. Candidate sites and associated vicinity properties designated by the DOE for inclusion in a remedial action program.

DEVIATION. Written authorization to depart from a particular requirement.

DISINTEGRATION, NUCLEAR. A spontaneous nuclear transformation (radioactivity) characterized by the emission of energy and/or mass from the nucleus of an atom. When large numbers of nuclei are involved, the process is characterized by a definite half-life.

DISTANCE TRANSDUCER. An optical device for measuring the distance traveled by the Gamma Scanning Van.

DOCUMENTATION. Any written or pictorial information describing, defining, specifying, reporting, or certifying activities, requirements, procedures, or results.

DOSE. The accumulated radiation delivered to the whole body or a specified part within a specified time interval, originating from an external or internal source.

DOSE EQUIVALENT. Quantity that expresses all radiations on a common scale for calculating the effective absorbed dose; the product of the absorbed dose in rads and certain modifying factors. The unit of dose equivalent is the rem.

DOSE RATE. The radiation dose delivered per unit time (e.g., rads per hour).

EFFECTIVE DOSE EQUIVALENT. (H_E or EDE) is the summation of the products of the dose equivalent received by specified tissues of the body and a tissue-specific weighting factor. This sum is a risk-equivalent value and can be used to estimate the health-effects risk of the exposed individual. The tissue-specific weighting factor represents the fraction of the total health risk resulting from uniform whole-body irradiation that would be contributed by that particular tissue. The effective dose equivalent includes the committed effective dose equivalent from internal deposition of radionuclides and the effective dose equivalent due to penetrating radiation from sources external to the body; it is expressed in units of rem (or sievert).

EFFICIENCY (COUNTERS). A measure of the probability that a nuclear disintegration will be detected when radiation is incident onto a detector.

EXPOSURE. A measure of the ionization produced in air by X or gamma radiation expressed in roentgens (R).

EXPOSURE PATHWAY. The pathway by which radioactivity travels in the environment to cause radiation exposure to man.

EXPOSURE RATE. Radiation exposure delivered per unit time, normally in roentgens per hour.

EXTERNAL RADIATION. Radiation from a source outside the body.

FIXED CONTAMINATION. Residual radioactive materials that cannot be easily removed from a surface by wiping the area.

GAMMA RADIATION. High-energy, short-wavelength electromagnetic radiation having a range of wavelengths from 10^{-9} to 10^{-12} cm.

GAMMA HOLE LOGGING. The process for determining the radioactivity profile of an augered hole.

GAMMA RAY SCAN. A measure of the gamma radiation level of surfaces using a portable gamma scintillation survey meter.

GAMMA SCANNING VAN. The modified vehicle that contains and transports the mobile gamma scanning instrumentation.

GAMMA SCINTILLATOR. A crystal detector that emits visible light in proportion to the intensity of a gamma-ray field. The visible light is converted to an electric current by a photomultiplier tube.

GEIGER-MUELLER COUNTER. Highly sensitive, gas-filled device for measuring radiation that operates at voltages sufficiently high to produce multiple ionizations from each interaction with radiation.

Ge(Li) DETECTOR. A radiation detector using a germanium (lithium drifted) crystal used for detecting X or gamma rays.

GRAY (Gy). The SI unit of absorbed dose equal to energy imparted by ionizing radiation to a mass corresponding to 1 J/kg (equals 100 rads).

GRID. A network of parallel horizontal and vertical lines forming squares on a map that may be overlaid on a property parcel for the purpose of identification of exact locations.

GRID BLOCK. A square defined by two adjacent vertical and two adjacent horizontal grid lines.

GRID POINT. The intersection of horizontal and vertical grid lines or the intersection of a grid line and the perimeter of a structure.

HALF-LIFE, RADIOACTIVE. Time required for one-half of the radioactive atoms present to disintegrate.

HEALTH PHYSICS. A term in common use for that branch of radiological science dealing with the protection of man from harmful effects of ionizing radiation.

HOT SPOT. A surface area exhibiting above-average radiation levels.

INSPECTION. A phase of quality control by means of examination, observation, or measurement to determine the conformance of materials, supplies, components, parts, appurtenances, systems, processes or structures to predetermined requirements.

INTERNAL RADIATION. Radiation from a source within the body (as a result of deposition of radionuclides in body tissue).

IONIZATION CHAMBER. An instrument that detects and measures ionizing radiation by measuring the electrical current that flows when radiation ionizes gas in a chamber, making the gas a conductor of the electricity.

IONIZING RADIATION. Any radiation (e.g., alpha, beta, or gamma) displacing electrons from atoms or molecules, thereby producing ions.

ISOTOPE. A nuclide of an element (i.e., having the same number protons and the same atomic number) that differs from the other nuclides of that element in the number of neutrons and, therefore, mass number. Virtually identical chemical properties are exhibited by isotopes of a particular element.

$L_{C.}$ The critical level (L_C) is the level, in counts, at which there is a statistical probability (with a predetermined confidence) of incorrectly identifying a background value as "greater than background."

$L_{D.}$ The detection limit (L_D) is an *a priori* estimated detection capability in units of counts.

LOWER LIMIT OF DETECTION. Lowest level of system response that can be statistically differentiated from background.

LOW-LEVEL RADIATION. Radiation that is of such intensity or concentration that it poses a minimal health hazard.

MINIMUM DETECTABLE ACTIVITY. The lowest level of radioactivity that can be measured precisely using a particular device.

MOBILE LABORATORY. A semitrailer or special vehicle equipped as a free-standing laboratory for on-site survey work.

MOBILE GAMMA SCANNING. Gamma radiation monitoring of vicinity properties using the Mobile Gamma Scanning Van.

MULTICHANNEL ANALYZER. An electronic device for sorting successive signal pulses into parallel amplitude channels.

NATURALLY OCCURRING RADIONUCLIDES. Radionuclides and their associated daughter products produced during the formation of the earth or by interactions of matter with cosmic rays.

NUCLIDE. A general term referring to any nuclear species of the chemical elements that exists for a measurable time.

PARENT. A radionuclide that, upon radioactive decay or disintegration, yields a nuclide (the daughter) either directly or as a later member of its radioactive series.

PHOTOPEAK. In an energy spectrum of a NaI(Tl) crystal detector, the pulse-height peak resulting from photoelectric effects from the interaction of the detector with gamma rays.

PRELIMINARY SURVEY. A radiological survey conducted on a site to determine if a radiological hazard exists or the site warrants a more comprehensive radiological survey because of the presence of residual radioactive materials.

PRESSURIZED ION CHAMBER. A pressurized ionization chamber, or ion chamber, is a detector that collects ion pairs formed by the interaction of radiation with high-pressure gases within the chamber.

PROCEDURE. A document that specifies or describes how an activity is to be performed. It may include methods to be employed, equipment or materials to be used, and sequence of operations.

PROCESSING SITE. As defined in Public Law 95-604, Sect. 101(6), (1) any site, including the mill, containing residual radioactive materials, at which all or substantially all of the uranium was produced for sale to any Federal agency prior to January 1, 1971, under a contract with any Federal agency, except in the case of a site at or near Slick Rock, Colorado, unless (a) such site was owned or controlled as of January 1, 1978, or is thereafter owned or controlled by any Federal agency or (b) a license (issued by the Nuclear Regulatory Commission or its predecessor agency under the Atomic Energy Act of 1954 or by a state as permitted under Sect. 274 of such act) for the production at such site of any uranium or thorium product derived from ores was in effect on January 1, 1978, or was issued or renewed after such date and (2) any other real property or improvement thereon which (a) is in the vicinity of such site and (b) is determined by the Secretary of Energy, in consultation with the Nuclear Regulatory Commission, to be contaminated with residual radioactive materials derived from such site.

PROCUREMENT DOCUMENTS. Contractually binding documents that identify and define the requirements that items or services must meet to be considered acceptable by the purchaser.

PROGENY. Descendants; used to mean the product of radioactive decay of an element; a nuclide remaining after radioactive decay.

PROPORTIONAL COUNTER. Gas-filled radiation detection tube in which the electrical pulse produced is proportional to the number of ions formed in the gas by the incident radiation.

PULSE-HEIGHT SELECTOR. A circuit designed to select and pass voltage pulses in a certain range of amplitudes.

PURCHASER. The organization or organizations responsible for issuance and administration of a contract.

QUALIFIED PROCEDURE. A procedure that incorporates all applicable codes and standards, operating parameters, and engineering specifications and has been proven adequate for its intended purpose.

QUALITY ASSURANCE. Those planned and systematic actions necessary to provide adequate confidence that a structure, system, or component will perform satisfactorily in service, including those actions that provide a means of controlling, calibrating, and measuring the characteristics of an item or process to established requirements.

RAD. The unit of absorbed dose equal to 100 ergs/g. The rad is a measure of the energy imparted to matter by ionizing particles per unit mass of irradiated material at the point of interest.

RADIATION. The emission and propagation of energy through matter or space by means of electromagnetic disturbances that display both wave-like and particle-like behavior; in this context, the "particles" are known as photons. Also, refers to the energy so propagated. The term has been extended to include streams of fast-moving particles (alpha and beta particles, free neutrons, cosmic radiation, etc.). Nuclear radiation is emitted from atomic nuclei in various nuclear reactions, including alpha, beta, and gamma radiation and neutrons.

RADIATION MONITORING. Continuous or periodic determination of the amount of radiation present in a given area.

RADIATION PROTECTION GUIDELINE. The officially determined radiation doses not to be exceeded without careful consideration. These standards are equivalent to what was formerly called the maximum permissible dose or maximum permissible exposure.

RADIATION SOURCE. Usually, a man-made, sealed source of radioactivity used in calibrations, teletherapy, as a power source for batteries, radiography, or various types of industrial gauges. Machines such as accelerators and radioisotopic generators and natural radionuclides may also be considered sources.

RADIATION STANDARDS. Exposure standards, permissible concentrations, rules for safe handling, regulations for transportation, regulations for industrial control of radiation, and control of radiation exposure by legislative means.

RADIOACTIVE WASTE. Equipment and materials from nuclear operations that are radioactive and for which there is no further use. Wastes are generally classified as high level (having radioactive materials concentrations of hundreds to thousands of curies per gallon or cubic foot), low level (in the range of 1 μCi/gal or ft^3), or intermediate level (between these extremes).

RADIOACTIVITY. The property of some elements to spontaneously emit alpha, beta, or gamma rays by the disintegration of the nuclei of atoms.

RADIOISOTOPE. A radioactive isotope; an unstable isotope of an element that decays or disintegrates spontaneously, emitting radiation. More than 1300 natural and artificial radioisotopes have been identified.

RADIOLOGICAL SURVEY. The process of measuring the various radiation levels associated with a specified site and the proper documentation and evaluation of the data.

RADIONUCLIDE. Any radioactive species of atom that exists for a measurable length of time. Individual radionuclides are distinguished by their atomic weight and atomic number.

RADIUM. A naturally occurring radionuclide having the atomic number 88.

RADON. The heaviest element of the noble gas group, it is produced as a gaseous emanation from the radioactive decay of radium. Its atomic number is 86. All isotopes are radioactive. The isotope ^{222}Rn has a half-life of 3.82 days.

RADON CALIBRATION CHAMBER. Enclosure used in the calibration of Wrenn Chambers in association with a radon source, transfer lines, sampling ports, humidity measuring devices, and air-purge systems.

RADON FLUX. The number of radon atoms migrating across a unit area within a specified time.

RADON SAMPLE/MEASUREMENT. Samples / measurements taken in which no specific consideration is given to the exact sampling / measurement location.

REM. Unit of dose equivalent; that quantity of any type of ionizing radiation that, when absorbed by man, produces equivalent specific biological effect to that produced by 1 rad of 250 keV X rays.

REMEDIAL ACTION. The activity of removing radioactive material or otherwise decontaminating candidate sites or vicinity properties.

REMEDIAL ACTION SITE. As defined in the Residual Radioactive Material Control Act, (1) a site at which remedial action is required and which was used under a contract with any predecessor of the Department of Energy, including the Manhattan Engineer District and Atomic Energy Commission for researching, developing, manufacturing, fabricating, testing, processing, sampling, or storing radioactive material, except a site (a) for which a license (issued by the Nuclear Regulatory Commission or its predecessor agency under the Atomic Energy Act of 1954, or by a state under Sect. 274 of that Act) for the production or possession at the site of uranium or thorium, their daughter products, including radium, is in effect on the date of enactment of the Residual Radioactive Material Control Act or is issued or renewed after that date or (b) owned or leased by the Federal Government on or after the date of enactment of the Residual Radioactive Material Control Act and (2) any other location the Secretary of Energy or his designee determines to require remedial action because of contamination with residual radioactive material derived from a site meeting the criteria of part (1) of this definition.

REPORT. A document that gives information for record purposes.

RESIDUAL RADIOACTIVE MATERIAL. Material (including but not limited to waste material, soils, rocks, plants, shrubs, personal property, and building materials) present at a site that results in radiation levels that exceed background levels.

RESIDUE. Material that remains after some fraction is removed.

RESTRICTED USE. A designation following remedial action that requires some control on the activities at a site containing radioactive material.

ROENTGEN (R). The unit of exposure of X or gamma radiation that will produce 2.58×10^{-4} C / Kg of charge in air.

SCINTILLATION COUNTER. The combination of phosphors, photomultiplier tube, and associated circuits for counting light emissions produced in the phosphors by incident ionizing radiation.

SI. International System of Units.

SIEVERT. An SI unit of dose equivalent that represents the absorption of 1 J/kg. One sievert equals 100 rem.

SMEAR COUNTER. A nuclear radiation counter used to count smear samples to determine the amount of transferable radioactive materials on surfaces.

SMEAR SAMPLE. A sample taken by "smearing" a piece of filter paper over suspected areas of surface contamination.

SODIUM IODIDE (NaI) DETECTOR. A detector that uses a sodium iodide (thallium activated) crystal for detecting gamma rays.

SPECIFIC ACTIVITY. The total radioactivity or that attributable to an identified nuclide per gram of specified material.

SPECIFICATION. A concise set of requirements to be satisfied by a product, material, or process; indicating, whenever appropriate, the procedure by which satisfaction of the requirements may be determined.

SPECTRUM. A visual display, photographic record, or plot of the distribution of the intensity of a given type of radiation as a function of its wavelength, energy, frequency, momentum, mass, or any related quantity.

STANDARD. The result of a particular standardization effort approved by a recognized authority.

SUBCONTRACTOR. A manufacturer or organization that receives a contract from a prime contractor for a portion of the work on a project.

SUBSURFACE SOIL SAMPLE. Soil sample taken from deeper than 15 cm below the soil surface level.

SURFACE BARRIER DETECTOR. A type of semiconductor detector, such as silicon, having a depletion region in the crystal and a thin gold film electrode.

SURFACE SOIL SAMPLE. Soil sample taken from the first 15 cm of surface soil.

SURVEILLANCE. The act of monitoring or observing to verify whether an item or activity conforms to specified requirements.

SURVEY METER. Any portable radiation detecting instrument especially adapted for surveying or inspecting an area to establish the existence of radioactive material.

SURVEY PLAN. A radiological survey plan for determining the radiological characteristics of a specific site.

SYSTEMATIC SAMPLE/MEASUREMENT. Samples/measurements taken under a definite method or plan.

TAILINGS. As defined in Public Law 95-604, Sect. 101(8), the term "tailings" means the remaining portion of a metal-bearing ore after some or all of such metal, such as uranium, has been extracted.

THORIUM. A naturally radioactive element having atomic number 90 and, as found in nature,

an atomic weight of approximately 232. The ^{232}Th isotope is abundant and can be transmuted to fissionable ^{232}U by neutron irradiation.

TRANSFERABLE CONTAMINATION. Radioactive contamination that can be transferred by contact with the contaminated object.

UNRESTRICTED USE. Any use without restraint on ownership, occupancy, or land.

URANIUM. A radioactive element having the atomic number 92 and, as found in natural ores, an average atomic weight of approximately 238. The two principal natural isotopes are ^{235}U (0.7% of natural uranium) and ^{238}U (99.3% of natural uranium). Natural uranium also includes a minute amount of ^{234}U. Uranium is the basic raw material of nuclear energy.

VERIFICATION. A documented act of confirming, substantiating, and ensuring that an activity or condition has been implemented in conformance with the specified requirements.

VICINITY PROPERTIES. Public or private properties in the vicinity of candidate DOE sites.

WATER SAMPLES. Samples of surface or subsurface water removed from a survey site for the purpose of chemical, physical, or radiological analysis.

WATER SEDIMENT SAMPLE. Sample taken of materials (soil, gravel, etc.) deposited under a surface water body for the purpose of chemical, physical, or radiological analysis.

WORKING LEVEL. Any combination of short-lived ^{222}Rn progeny in 1 L of air such that the ultimate emission of alpha particle energy is 1.3×10^5 MeV.

WRENN CHAMBER. A device used for measuring radon gas concentrations in air by diffusion and direct nuclide counting.

X RADIATION. Electromagnetic radiation having wavelengths shorter than those of visible or ultraviolet light and originating from electron energy level transfers outside the nucleus of an atom.

ZINC SULFIDE (ZnS) DETECTOR. A detector that uses ZnS powder as the detection medium that is used for detection of alpha particles or other heavy ions.

10.2 ABBREVIATIONS

Standard prefixes may be used with unit abbreviations.

m	milli	10^{-3}	k	kilo	10^{3}
μ	micro	10^{-6}	M	mega	10^{6}
n	nano	10^{-9}	G	giga	10^{9}
p	pico	10^{-12}	T	tera	10^{12}
f	femto	10^{-15}	P	peta	10^{15}
a	atto	10^{-18}	E	exa	10^{18}

Other standard abbreviations are:

alpha	α	gram	g
becquerel	Bq	gray	Gy
beta	β	hectare	ha
centigrade	C	hour	h

counts per minute	cpm	inches	in.
cubic feet	ft^3	liter	L
cubic meters	m^3	meter	m
curie	Ci	metric ton	MT
disintegrations per minute	dpm	minute	min
electron volt	eV	roentgen	R
feet	ft	second	s
gamma	γ	working level	WL

10.3 ACRONYMS

AEA	Atomic Energy Act
AEC	Atomic Energy Commission
ALARA	as low as reasonably achievable
ANSI	American National Standards Institute
ASTM	American Society for Testing and Materials
CAA	Clean Air Act
CERCLA	Resource Conservation and Recovery Act
CWA	Clean Water Act
DCG	derived concentration guideline
DOE	Department of Energy
DQO	Data quality objectives
EML	Environmental Measurements Laboratory
EPA	Environmental Protection Agency
GM	Geiger-Mueller
HASP	health and safety plan
HPGe	high-purity germanium
ICRP	International Commission on Radiological Protection
LLD	lower limit of detection
MED	Manhattan Engineer District
MDA	minimum detectable activity
MPC	maximum permissible concentration

NaI	sodium iodide
NaI(Tl)	thallium-activated sodium iodide crystal
NBL	New Brunswick Laboratory
NCRP	National Commission on Radiological Protection
NEPA	National Environmental Policy Act
NIST	National Institute for Science and Technology
NRC	Nuclear Regulatory Commission
OOS	Office of Operational Safety
ORISE	Oak Ridge Institute for Science and Education
ORNL	Oak Ridge National Laboratory
ORO	Oak Ridge Operations (DOE)
PERM	passive environmental radon monitor
PIC	pressurized ion chamber
QA	quality assurance
QC	quality control
SAFER	Streamlined Approach for Environmental Protection
TLD	thermoluminescent dosimeter
TOSCA	Toxic Substances Control Act